

Mole in Chemistry

(Not the cute burrowing animal!)



Learning Outcomes

Students will display the ability to:

- Construct a graphic organizer to assist with molar conversions
- Convert moles to particles, moles to grams and particles to grams

Time Requirements

Part 1: 1 hour, 20 minutes

Part 2: 1 hour, 20 minutes

Materials

Reproducible student handouts

Cardboard cutouts (template supplied)

Common Core Standards (2010)

High School Mathematics

Number and Quantity N-Q.1

Reason quantitatively and use units to solve problems: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Maine Parameters of Essential Instruction (2007)

High School Science and Technology

D3: Students describe physical and chemical properties of matter, interactions and changes in matter, and transfer of energy through matter.

Prerequisites

Students need to know how to

- multiply ratios,
- definition of atomic mass unit (amu),
- calculate with scientific notation,
- significant figures and
- convert words into chemical formulas.

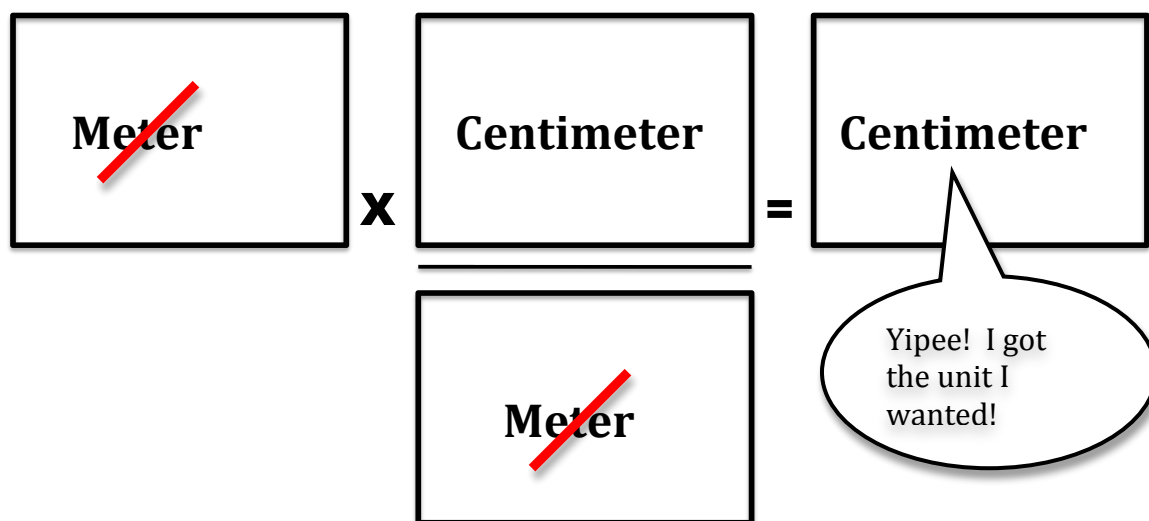
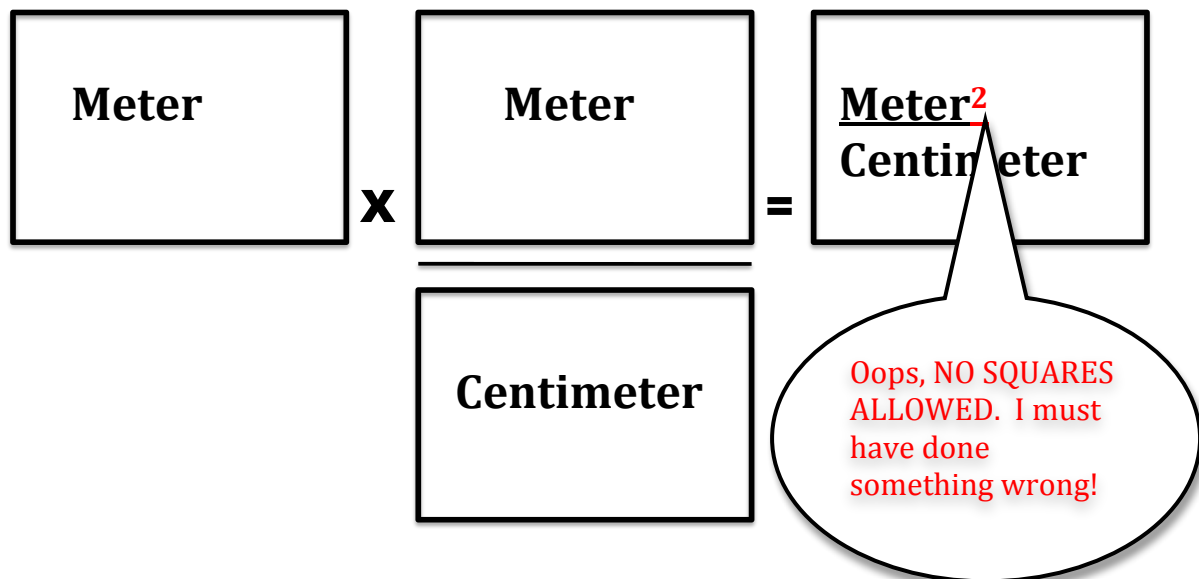
Overview

After a brief introduction to the concept of moles and Avogadro's number, students will create a graphic organizer to assist in the conversion of moles to particles, moles to grams and particles to grams. Students will then learn how to use units to calculate the conversions. Observation and student-created graphic organizers will be the formative assessment. Formal assessment will be a quiz on the conversions with a summative assessment at the end of the chapter.

Part 1

Suggested time: 1 hour, 20 minutes

1. Writing prompt at the beginning of the period:
 - a. Give two examples of when have you converted from one measurement to another. Hint: When I visited Canada this summer, I had to convert from Celsius to Fahrenheit to know what the temperature would be.
 - b. How did you do the conversions in your example?
2. Write/pair/share
3. Share the next writing prompt and tell students to be watching and listening for the answers in the video:
 - a. Using words, write two definitions of mole.
 - b. Write two different mole equations.
4. Introduce the concept of a mole by watching <http://www.khanacademy.org/video/the-mole-and-avogadro-s-number?playlist=Chemistry>
5. Do the writing prompt in step 3.
6. Think/pair/share. Then share with a table group of four. The teacher randomly picks a student (mother's birthday closest to the current date) from each table to report to the class.
7. If necessary, the teacher provides direct instruction on the two definitions of a mole and the two equations.
8. Distribute Student Handout 1 and two sets of cutouts to each student.
9. The teacher will demonstrate how to use the handout with an example using meters and centimeters.



10. Complete Student Handout 1 in pairs and then share in table groups of 4. Each student should have a completed handout for future use.
11. Distribute Student Handout 2. Students already have two sets of cutouts.
12. Complete Student Handout 2 in pairs and then share in table groups of 4. Each student should have a completed handout for future use.

13. Distribute Student Handout 3. Students already have two sets of cutouts. Ask students to
READ and FOLLOW the directions.
14. Complete Student Handout 3 in pairs and then share in table groups of 4. Each student
should have a completed handout for future use.
15. Writing prompt:
 - a. What would make it easier to learn the rules?
16. Think/pair/share. Then share with a table group of four. The teacher randomly picks a
student (first initial closest to the end of the alphabet) from each table to report to the
class.
17. The teacher explains that we'll explore multiple ways to do molar conversions and
students can choose the way(s) that make sense to them.
18. Handout Student Handout 4. Students will work with their table group of 4. By the
beginning of next class, each student will need a copy of the graphic organizer.
19. Handout Exit Card for students to complete individually.
20. The teacher can modify Part 2 based on feedback from the Exit Card.

Part 2

Suggested time: 1 hour, 20 minutes

1. Writing prompt at the beginning of the period:
 - a. Without using any resources except your brain, define a mole. You may use
words or equations.
2. Write/pair/share
3. Group students so they are with a different group than the previous class. The purpose of
the grouping is to see and use different graphic organizers.

4. Explain to students that the dual purpose of this activity. First, they will learn how to do problems involving molar conversions. Second, they will see and use other graphic organizers so they can modify their own based on what works.
5. In groups of 4, do the problems using the graphic organizers. Each group is assigned ONE of the problems sets (Part 2: Student Handout 1). Each student will be responsible for being the “expert” when he/she returns to his/her home group.
6. Writing prompt:
 - a. In terms of your graphic organizer, what worked?
 - b. What didn’t work so well?
 - c. How could you modify your graphic organizer to make it better?
 - d. Make those modifications.
7. Students return to their original groups from the first day. They will work on all FOUR problem-sets (Part 2: Student Handout 1) with help from the “expert” from each set.

[This is a common practice in my class so students will understand the procedure without much direction.]
8. Near the end of the period, the teacher will ask, “On a scale of 1 to 5 with 1 being ‘I’m lost’ and 5 being ‘I get this so well that I’m ready to move on,’ show me with your fingers where you are.” [Again, this is a common practice by this time in the year. The trust and safety level is high enough that they have no problem being honest with their assessment and no problem showing the class and me.]
9. If time allows, think/pair/share on what it would take to get everyone to a 4 level. Share at the table group and report out by random student (the one with the largest sum of last three digits of their phone number).

10. Modify the next class's instruction based on answers to 8 and 9. Also announce the timing of the quiz based on the answer to 8.

Rationale Based on Research

The lesson plan is based on a constructivist approach. Through cooperative learning (working in pairs and at times in groups of 4), students construct rules for molar conversion and then a graphic organizer to represent the rules. This takes place during the explanation phase of the learning cycle. During the exposition phase, students use their organizer to solve problems and modify their organizer. All is based on research discussed in EDU 561.

Based on my research project on sex differences in mathematics, the lesson approaches conversion from a variety of strategies. In particular, frequent writing prompts and stating the rules in words will help verbal learners. Moving the cutouts around to find out how they cancel will assist spatial and kinesthetic learners. Filling in the graphic organizer and creating the graphic organizer is designed for the visual learners.

The lesson involves many of the principles outlined in Jayanthi, Gersten, and Baker (2008). Explicit instruction will be used based on teacher observation of the group activities. Students will have the opportunity by the end of Part 2 to solve four problems of each type of conversion. By working in groups to solve the problems, students must verbalize the solutions as they do the problems in their expert group and as they teach members of their home group. The Part 1 handouts and the self-created graphic organizer are visually representations of the math problem. Formative assessment includes teacher observations, the ending activity in both parts, and a quiz when students are ready.

Alternative Teaching Strategies (RTI)

The teacher will provide more explicit instruction to struggling learners. This may happen in the classroom or outside of class. Students are aware of and take advantage of the teacher's study hall, planning period and after school time, including Thursdays in the library until 4 p.m. During the extra instruction, the teacher tries to get the student to articulate the issue. Then the teacher and learner move from there based on individual needs. In terms of problem solving, the teacher uses a gradual release model of doing a problem with thinking aloud, then the student and the teacher work together on another problem, finally the student solves a third problem independently. This cycle may have to be repeated.

If a student struggles with an issue, the teacher may pair that student with another student who understands the issue. For example, if the student has difficulty multiplying with scientific notation, the teacher may ask a "more expert" student to help. Peer-assisted instruction is build into the lesson with the cooperative learning strategy. However, struggling students may receive additional help outside the classroom from peers via National Honor Society or Peer Helper tutoring.

The teacher has access to many problem sets and examples of molar conversions. If the student needs additional practice, the material is readily accessible on-line, in the textbook or in hard copy. One resource that may help is

http://nlvm.usu.edu/en/nav/frames_asid_272_g_4_t_4.html?open=instructions&from=topic_t_4.html -- a virtual manipulative on unit conversion.

Use of Technology

The video from Khan Academy will be projected with a ceiling-mounted LCD projector. The video provides a change of pace for students who are tired of their teacher's voice. The novelty of seeing a video in chemistry may be a hook to interest some.

In Part 1, students may create their graphic organizers using pen and paper or they may use Inspiration, a software package that allows students to create visuals.

During Part 2, students will use calculators to do the computations.

Student Handout 1

Name _____ Partner's Name _____

Use the cardboard cutouts to complete the following conversions. Remember, NO SQUARES ALLOWED!

Moles to particles (a particle can be an atom, molecule, ion or electron)

$$\boxed{} \times \boxed{} = \boxed{}$$
$$\boxed{}$$

What rule can you use to convert from moles to particles?

Particles to moles

$$\boxed{} \times \boxed{} = \boxed{}$$
$$\boxed{}$$

What rule can you use to convert from moles to particles?

Student Handout 2

Name _____ Partner's Name _____

Use the cardboard cutouts to complete the following conversions. Remember, NO SQUARES ALLOWED!

Moles to grams

<div></div>	x	<div></div>	=	<div></div>
		<div></div>		

What rule can you use to convert from moles to particles?

Grams to moles

<div></div>	x	<div></div>	=	<div></div>
		<div></div>		

What rule can you use to convert from moles to particles?

Student Handout 3

Name _____ Partner's Name _____

Remember, NO SQUARES ALLOWED!

Grams to particles (a particle can be an atom, molecule, ion or electron)

First, draw your graphic organizer (the squares similar to the ones on the first two handouts). Ask your teacher to check your graphic organizer. THEN use your cutouts to complete the conversion. *Hint: you may have to use more than one conversion.*

What rule can you use to convert from moles to particles?

Particles to grams

First, draw your graphic organizer (the squares similar to the ones on the first two handouts). Ask your teacher to check your graphic organizer. THEN use your cutouts to complete the conversion. *Hint: you may have to use more than one conversion.*

What rule can you use to convert from moles to particles?

Cardboard Cutouts

Mole

Particle

Gram

Mole

Particle

Gram

Mole

Particle

Gram

Mole

Particle

Gram

Mole

Particle

Gram

Mole

Particle

Gram

Student Handout 4

Name _____

With your table group, create a way of graphically representing all of the rules you discovered. A graphical representation is NOT a list of the rules. A graphic organizer could be a picture or a flowchart.

Use this space to create your graphical organizer OR you may use Inspiration.

Name _____ Date _____ Period _____

Exit Card

Please write AT LEAST 2 statements for each question:

1. What did you learn today?
 2. What worked well for you today?
 3. What is still unclear or confusing to you?
-

Name _____ Date _____ Period _____

Exit Card

Please write AT LEAST 2 statements for each question:

1. What did you learn today?
2. What worked well for you today?
3. What is still unclear or confusing to you?

Part 2: Student Handout 1

Team A –

To be correct, the answer must have:

1. Show the work to determine your answer
2. Correct number of significant figures
3. Correct scientific notation
4. Correct value or number
5. Correct unit

1. How many atoms are there in 1.45×10^{-17} mol of arsenic?

2. Find the mass in grams of 4.96 mol titanium (molar mass of Ti = 47.88 g/mol)?

3. Find the mass in grams of 3.01×10^{23} particles of NaCl (molar mass of NaCl = 58.44 g/mol)?

Part 2: Student Handout 1

Team B –

To be correct, the answer must have:

1. Show the work to determine your answer
2. Correct number of significant figures
3. Correct scientific notation
4. Correct value or number
5. Correct unit

1. A biologist estimates that there are 2.7×10^{17} termites on Earth. How many moles of termites is this?

2. How many moles of gold are there in a pure gold ring with a mass of 10.6 g?
Atomic mass of Au is 196.967 g/mol.

3. Find the number of atoms in 237 g Cu (molar mass of Cu = 63.55 g/mol).

Part 2: Student Handout 1

Team C –

To be correct, the answer must have:

1. Show the work to determine your answer
2. Correct number of significant figures
3. Correct scientific notation
4. Correct value or number
5. Correct unit

1. How many molecules are there in 4.224 mol of acetic acid, $\text{C}_2\text{H}_4\text{O}_2$?

2. How many moles are in 302.48 g of ZnCl_2 ? The molar mass of zinc chloride is 136.29 g/mol.

3. Find the mass in grams of 3.9990×10^{25} molecules of CH_4 (molar mass of CH_4 = 16.05 g/mol)?

Part 2: Student Handout 1

Team D –

To be correct, the answer must have:

1. Show the work to determine your answer
2. Correct number of significant figures
3. Correct scientific notation
4. Correct value or number
5. Correct unit

1. How many particles are there in 5.9 mol of NaOH?

2. Find the number of ions in 20.0 g Ca^{2+} (molar mass of $\text{Ca}^{2+} = 40.08 \text{ g/mol}$).

3. Find the number of atoms in 155 g of arsenic. The molar mass of As is 74.921 g/mol.

Name _____ Date _____ Period _____

Section 7.1 Quiz: Avogadro's Number and Molar Conversions

You must attempt to earn a total of 6 points on this quiz. Each problem is worth one point. To be correct, the answer must have:

1. Show the work to determine your answer
2. Correct number of significant figures
3. Correct scientific notation
4. Correct value or number
5. Correct unit

Completely correct answer earns 1 point. If you make minor mistakes in one or more of the steps, you will earn 0.5 points. If you do not set up the problem correctly or do not show your work AND get a wrong answer, you will earn 0 points.

For each question, you must do either A or B. Circle the letter of the questions you choose to be counted.

1. Choose either A or B
 - A. Find the number of K^+ in 0.25 mol K^+
 - B. How many molecules are in 3.000 moles of a certain compound?

2. Choose either A or B
 - A. Find the number of moles in 3.011×10^{10} ions Na^+
 - B. How many moles in 1.275×10^{-2} molecules of water?

3. Choose either A or B

- A. Find the mass in grams of 6.022×10^{23} molecules of CH_4 with a molar mass of 16.05 g/mol.
- B. What is the mass of 6.022×10^{23} molecules of ibuprofen (molar mass of 206.31 g/mol)?

4. Choose A or B

- A. Find the number of Cu^{2+} ions in 14.0 g Cu^{2+} with a molar mass of 63.55 g/mol.
- B. How many molecules of magnesium iodide are in 100 g of magnesium iodide. Hint: you first need to write the correct formula for magnesium iodide then you need to calculate the molar mass. Hint 2: you will see a problem like this on the chapter test.

5. Choose A or B

- A. How many moles of ibuprofen are in a bottle that contains 66 g of ibuprofen? The molar mass of ibuprofen is 206.31 g/mol.
- B. Determine the mass in grams of 2.010×10^{12} mol cobalt.

6. Choose A or B

- A. Determine the amount (in moles) of 348 g chlorine.
- B. How many moles in 0.0743 g fluorine?

D-3: Students describe physical and chemical properties of matter, interactions and changes in matter, and transfer of energy through matter.

Excel at the Standard 4	Meets the Standard 3	Partially Meets the Standard 2	Does NOT Meet the Standard 1
6 to 5.5 points	5 to 4.5 points	4 to 3.5 points	Less than 3.5 points